



Parallel Computing Sciences Department

CUBIT 2.0 User Release

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CUBIT Development Team**

**Sandia National Labs
July 8, 1997**

Introduction



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- Purpose: provide a *user-oriented* description of CUBIT 2.0
- CUBIT 2.0 is the culmination of a year's effort focused on usability
- We intend CUBIT to be a production-capable mesh generation tool for National Lab applications
- Talk will be loosely categorized, with examples
- Close with discussion of future directions and also consultation on user problems

Outline



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- **Introduction**
- **Project News**
- **Geometry**
- **Mesh**
- **User Interface / Graphics / Post-processing**
- **Applications**
- **Known Bugs**
- **Future Plans**

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CUBIT Project

CUBIT Code Status

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- CUBIT 2.0 is ready and will be released this week (promise!)
- CUBIT User's Guide will be updated and available in about 4 wks
- CUBIT is being distributed over the web - email/call Tim Tautges (tjtautg@sandia.gov, 505-844-5388) for details
- Web-based bug reporting system now available; see
<http://endo.sandia.gov/cgi-bin/wwwgnats.pl>
- CUBIT User Tutorial materials also online, at
<http://endo.sandia.gov/SEACAS/CUBIT/workshop/schedule.html>

Geometry Infrastructure

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- CUBIT 2.0 contains the Virtual Geometry Interface (VGI); allows:
 - Simple substitution of other engines (e.g. Pro/E)
 - Use of alternative representations (e.g. composite geometry)
- ACIS 1.7 and 2.1 are now supported

Geometry New Capabilities

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- Persistent booleans
- 2D geometry construction
 - Interactive creation of vertex/curve/surface
- Imprint all
 - Includes bounding box check for efficiency
- Move location
 - Moves a body to the location of another piece of geometry

Geometry Interface Improvements

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- Export ACIS available for individual bodies
- Geometry merge can be disabled for individual entities
- Lump keyword removed

Geometry Robustness Improvements

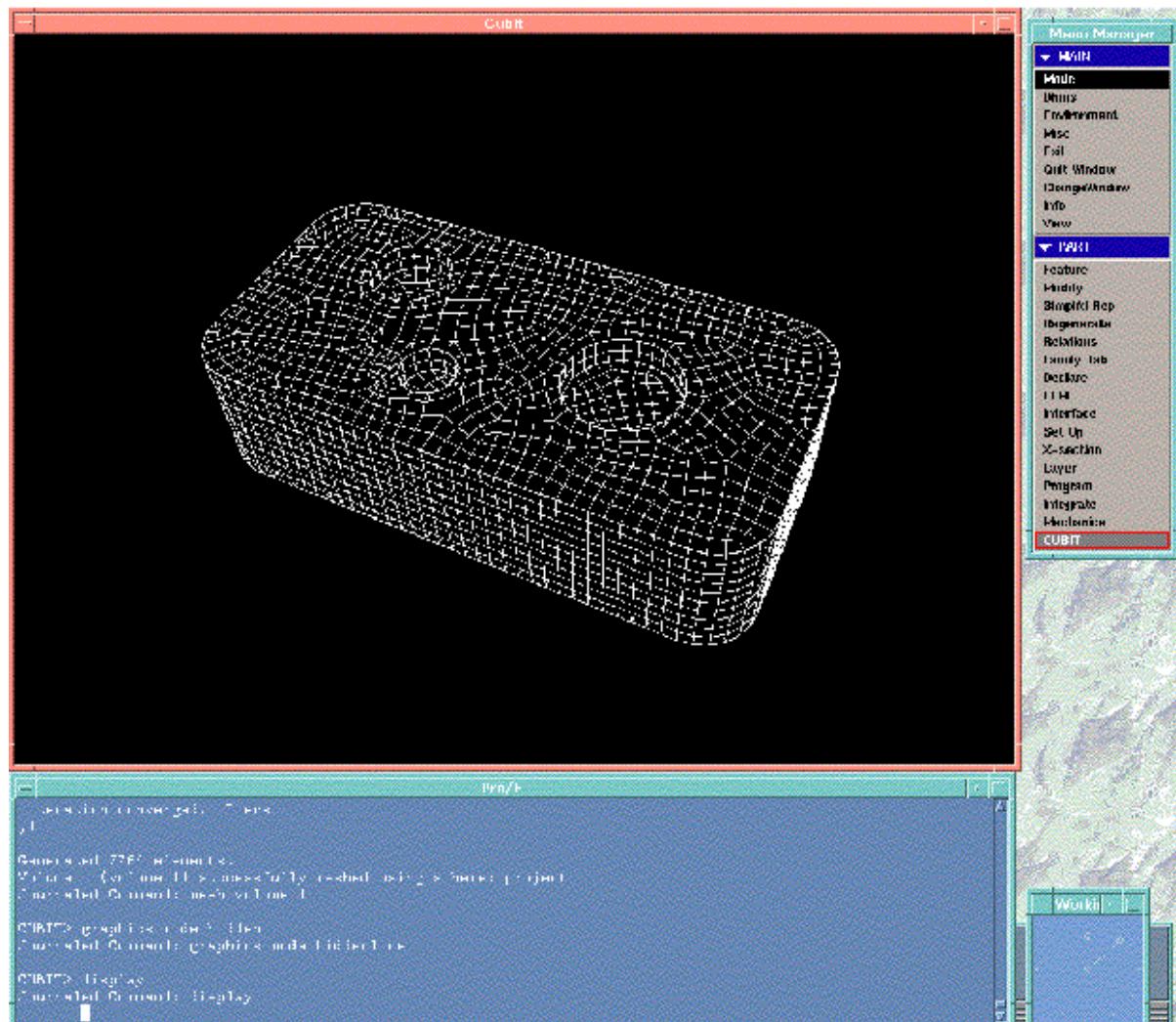
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- Better support for geometry names
 - Propagation due to booleans
 - Read/write to/from ACIS file
- Validate geometry
 - Checks for bad/questionable ACIS geometry

Geometry CUBIT/ProE (Courtesy of Caterpillar, Inc)

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Geometry Summary

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- Major bugs fixed:

- ACIS 2.1 imprints more robust
- Boolean failure handled much more gracefully

- New commands:

- Intersect [body] <body_id_range> [With [body] <body_id_range>] [keep]
- Create Curve [Vertex] <vertex_id> [Vertex] <vertex_id> [Vertex] <vertex_id> [Parabolic]]
- Create Vertex <xval> <yval> <zval>
- Create Surface [Curve] <curve_id> [Curve] <curve_id> ...
- Imprint [body] <body_id_range> [With [body] <body_id_range>] [keep]
- Move entity <id_range> location [x <val>] [y <val>] [z <val>] [except [x] [y] [z]]
- Export Acis '<filename>' [Body <body_id_range>]
- Curve <curve_id_range> Merge [on|off]
- *** WARNING: Please use 'volume' instead of 'lump' ***
- Validate {Body|Volume|Surface|Curve|Vertex|Group} <range>

Mesh Infrastructure

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- Firmness
 - Distinguishes between default and user-specified values
 - Used in interval and mesh scheme settings
 - Possible values: Soft, Hard, Default
 - User can specify firmness explicitly, or implicitly by setting values
- Delete mesh propagate allows deletion of mesh on bounding entities

Mesh New Capabilities

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- Auto scheme select for surfaces, volumes
 - Auto surface scheme chooses between pave, map, submap, triangle
 - Auto volume chooses between map, submap, project, multi-project
 - Auto sweep detect also detects source, target surface(s)
 - Source, target surface(s) can also be selected by substring in name
- New face-by-face paver substantially improves robustness, quality
- Circle tool: creates block-structured meshes for surfaces with circle-like topology

Mesh New Capabilities (cont)

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- Dicer refines coarse all-hex mesh into finer hexes
 - Reduces time, memory to generate large meshes
- Morph/copy/mirror
 - Copies meshes between surfaces with different geometry, topology
 - Orientation can be specified (allows flip), or chosen automatically

Mesh Interface Improvements

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- Default surface mesh scheme user-controllable (used to be mapping)
- Volume smooth tolerance, iteration count user-controllable

Mesh Robustness Improvements

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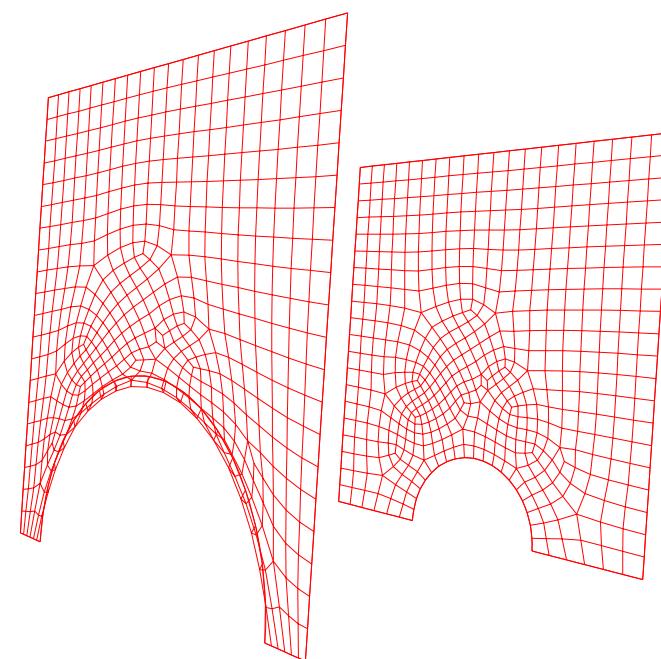
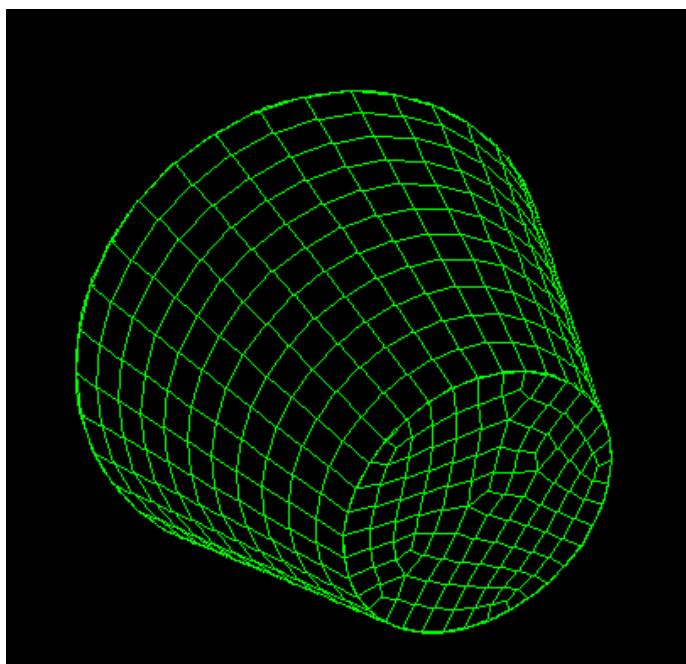


- Project distortion
 - Laplacian smooth scheme used to smooth layers by default
 - Smooth scheme is user-controllable
 - General performance is greatly improved
- Pave smooth method user-controllable (defaults to old behavior)
- Paving warns about poorly shaped elements
- Import surface mesh more robust and faster (still needs improvement)

Mesh Example: Project Layer Smoothing



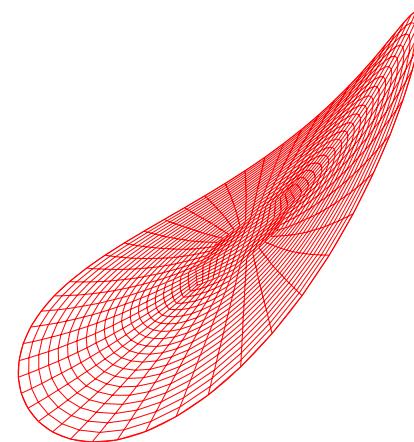
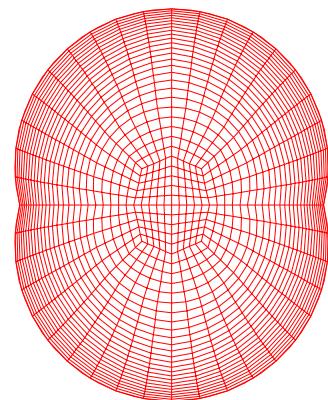
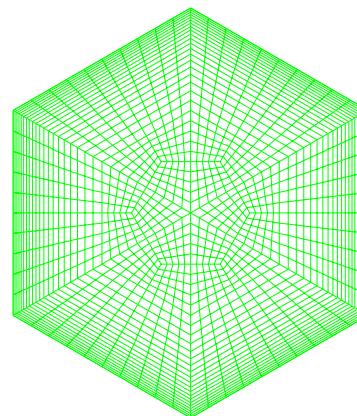
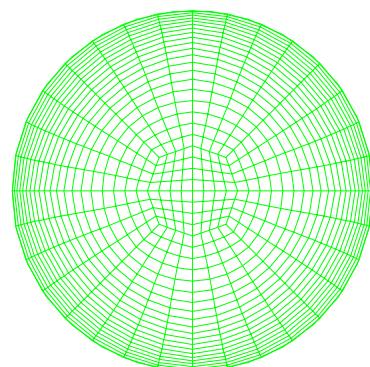
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Mesh Example: Circle Tool

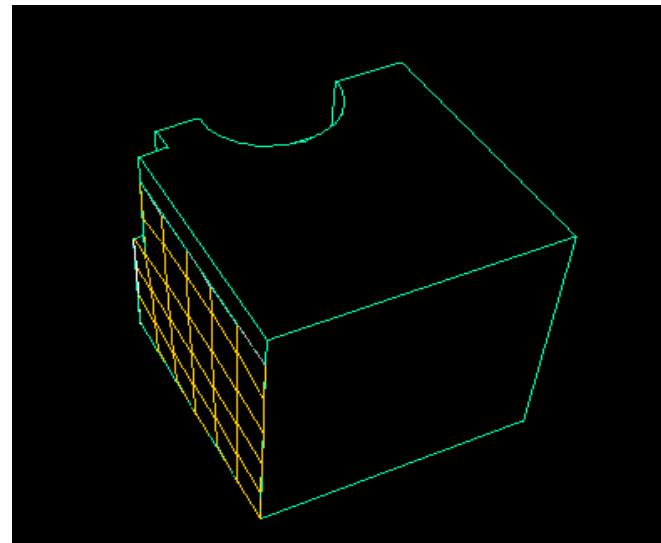
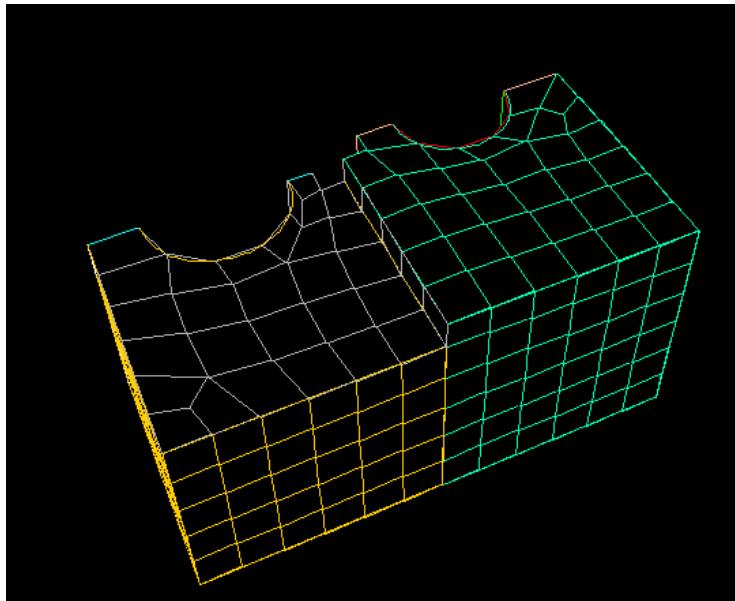


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Mesh Example: Delete Mesh Propagate

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- **volume 8 19 size .2 scheme auto**
- **mesh volume 8 19**
- **draw volume 8 19**
- **delete mesh volume 19 propagate**
- **draw volume 19**

Mesh Summary



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- Major bugs fixed:

- Project distortion
- Paver robustness, quality

- New commands:

- Volume <volume_id|all> Scheme Auto (Automatically select scheme)
- Surface <surface_id_range|all> Scheme Auto (Automatically select scheme)
- set {source|target} surface pattern '<pattern>' [include volume name]
- Curve <curve_id_range> DicerSheet Interval <interval>
- DicerSheet <id_range> interval <interval>
- Surface <surface_id_range> Initialize Dicer
- Surface <surface_id_range> Scheme Dice
- Surface <surface_id_range> Scheme Circle Interval <m>
- Delete Mesh [{group|body|volume|surface|curve|vertex} <id_range> [propagate]]

Mesh Summary (cont)



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- **New commands (cont):**

- Surface <surface_id_range> Scheme Morph
[[Source Surface <id_range>] {orientation_data}]
where orientation_data = { Source Node <id_range> Target Node <id_range> |
Source Edge <id_range> Target Edge <id_range> |
Source Vertex <id_range> Target Vertex <id_range> |
Source Curve <id_range> Target Curve <id_range> }
- [set] Smooth Method {laplacian | isoparametric}
- [set] Project Smooth [on|off]
- [set] Paver Smooth Method { Default | Smooth Scheme }
- Surface <surface_id_range> Interval {Default|Soft|Hard|Even|Odd}
- Surface <surface_id_range> Scheme {Default|Soft|Hard}
- Surface Default Scheme Pave
- Volume Smooth Tolerance {value} (Default = .05)
- Volume Smooth Iterations {value} (Default = 18+(num hexes/nodes)^.33333)

User Interface / Graphics / Post-Proc'g New Capabilities



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- Geometry entity (and other) parsing has gotten lots more flexible
 - Range parsing: 1 to 10 by 2, 1 3 5 7 9, 1 to 7 by 2 9, all
 - In: Surface all in volume 3
 - Except: Surface all except 2
- Group functionality has vastly improved
 - Group booleans: intersect, unite, subtract
 - Group functions: XOR, name pattern, scheme
- Graphics status can be toggled on/off during session
- Entities can be labeled with id, name, interval, size, merge status, or firmness
- Geometry entities can be removed from element blocks, nodesets & sidesets

User Interface / Graphics / Post-Proc'g Interface Improvements



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- On/off setting commands now toggle if on/off is omitted
- Comment command journals comments

User Interface / Graphics / Post-Proc'g Example: Geometry Entity Parsing



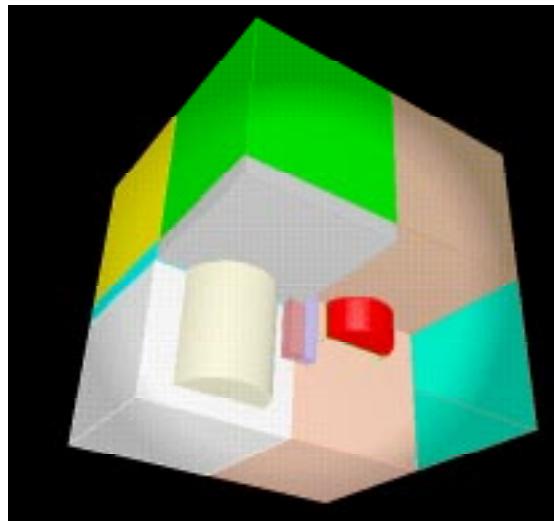
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- Surface **all** visibility on
- Surface **1 2 .. 9 13 .. 30** visibility on
- Surface **1 to 9 12 to 30** visibility on
- Surface all **in** volume **1 to 10** visibility on
- Surface all **except** **10 11** visibility on

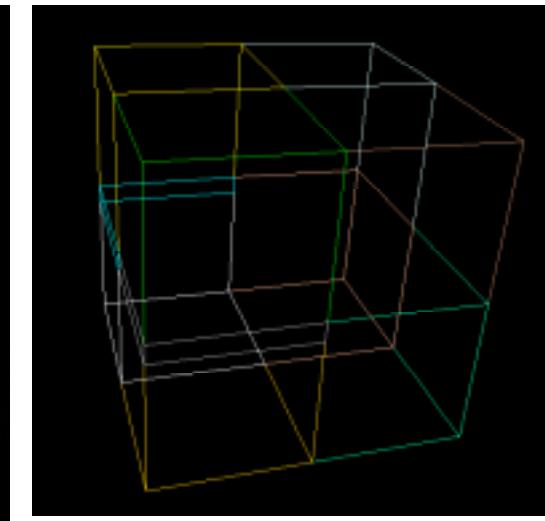
User Interface / Graphics / Post-Proc'g Example: Group Functionality



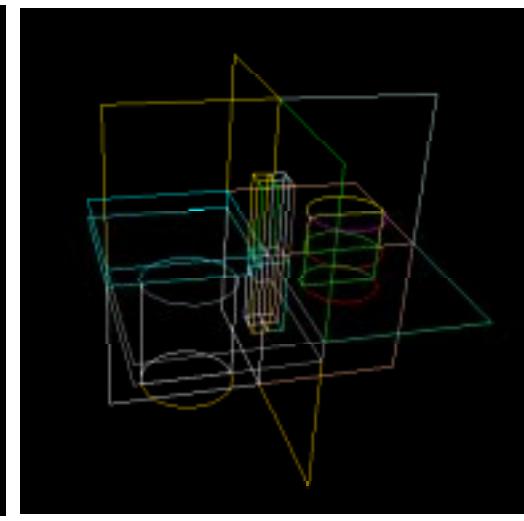
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(Initial body)



- group "shellsurf"
xor surface all in
volume all



- group "surfs" add
surface all
- surfs subtract
shellsurfs from
surfs

User Interface / Graphics / Post-Proc'g Summary



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- Major bugs fixed: many parsing bugs (still looking for more!)
- New commands:

- Group {<'name'>|<id>} {add|equals|remove|xor} <geometry_entities>
- Group {<'name'>|<id>} {add|equals|remove|xor} <entity_type> [name|scheme] 'pattern'
- Group {<'name'>|<id>} {add|equals|remove|xor} [expand] Group {<ids>|name 'pattern'}
- Graphics [status] [on|off]
- Curve <curve_id_range> Label [on|off|name|interval|id|size|merge|firmness]
- Block <id> <geometry_type_name> <geometry_id_range> [Remove]
- Comment '<text_written_to_journal_file>'
- Label Node [on|off]

CUBIT Applications

MC4380 Neutron Generator (summary)

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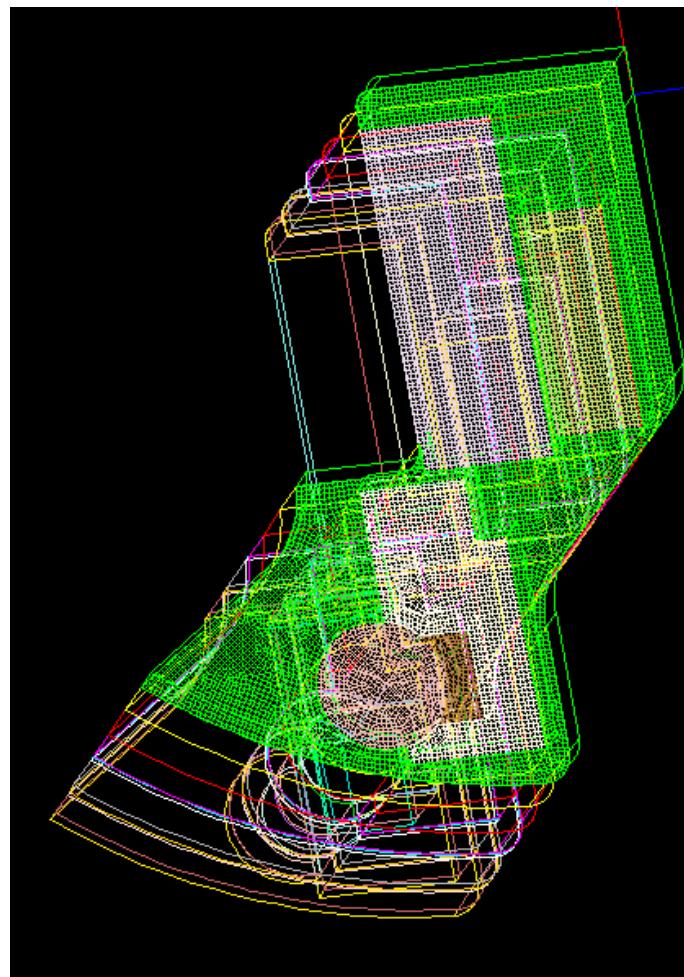
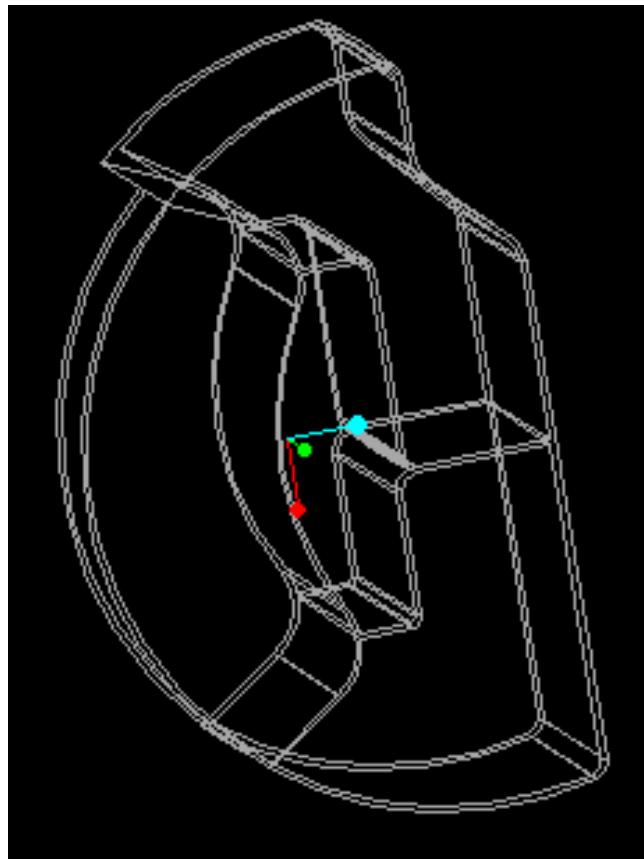
- **Initial Geometry:**
 - 21 Volumes
 - 299 Surfaces
 - 755 Curves
- **Decomposed Geometry:**
 - 184 Volumes
 - 897 Surfaces
 - 1413 Curves
- **Mesh:**
 - 7.73 Million Elements
 - 7.43 Million Nodes
 - 30 Element Blocks
 - 11 Side Sets
- **Miscellaneous**
 - CPU Time: ~3.5 hrs
 - Memory Usage: 500 MB*
 - Effort: ~ 1.3 man-year

CUBIT Applications

W80 Fireset Housing (D. Hensinger)



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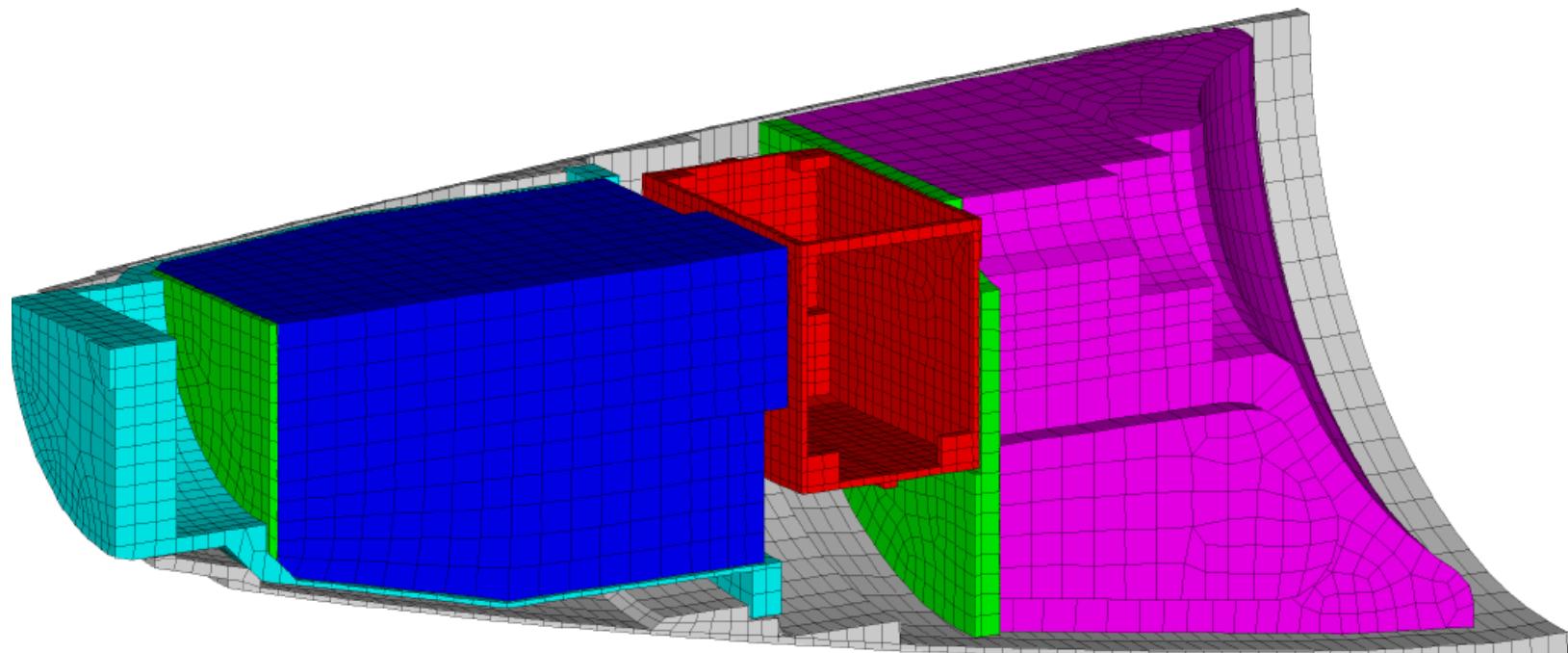


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B61 Nose (J. Gruda)



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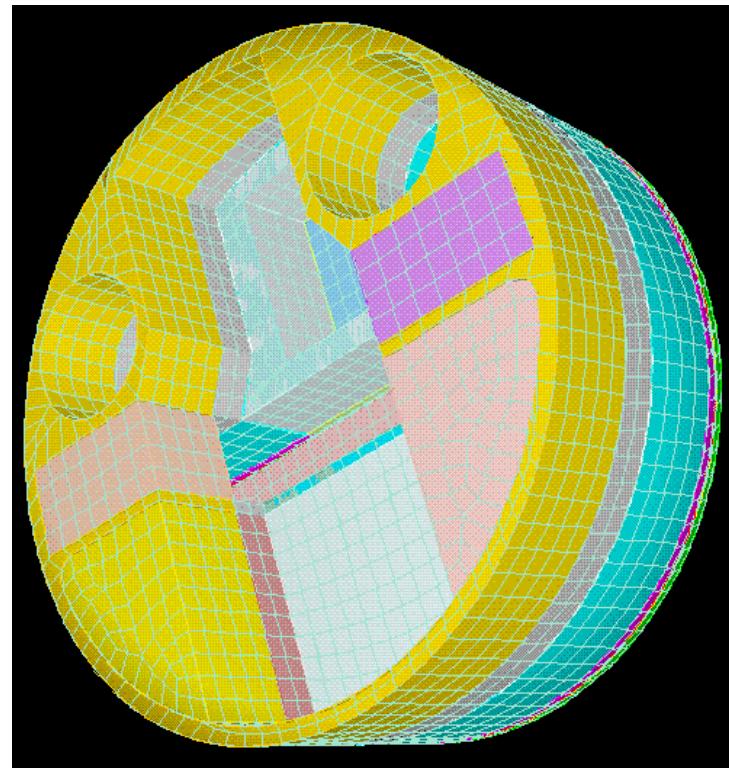
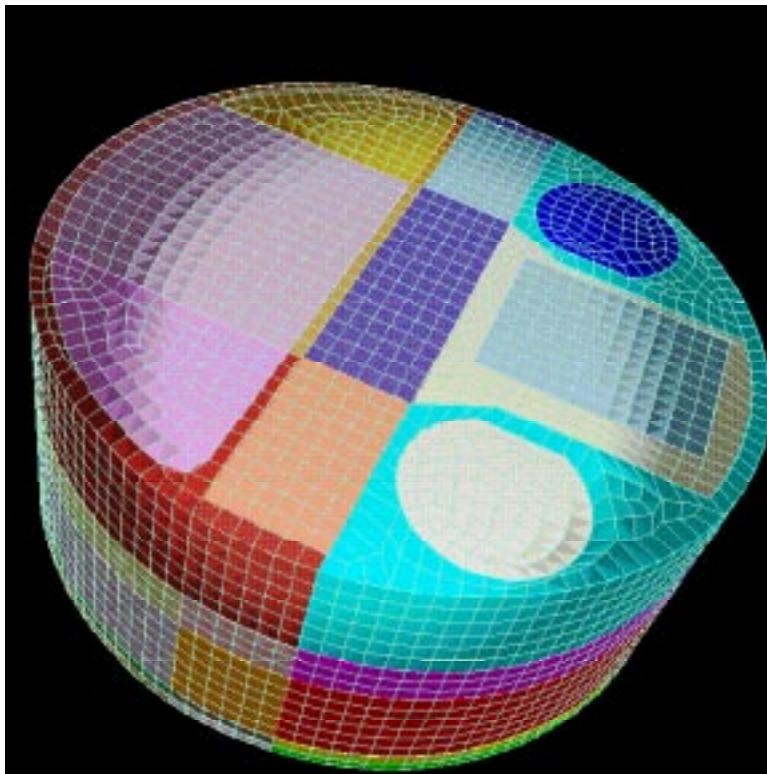


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B61 ECA Deck (S. Smith)



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CUBIT Applications

MC4380 Neutron Generator Tube



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CUBIT 2.0 Known Bugs



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- Submap intervals on E, L
- Project distortion for concave volumes
- Imprint on non-regular geometry
- Geometry entity names not journaled
- Graphics memory usage
- VGI query times

- Merge sense entities warnings in VGI
- Compress ids doesn't reset color numbers
- Non-linear geometry performance after many booleans

Future Plans



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- Long-range planning (7/9/97)
- Whisker weaving*
- Hex/tet plastering*
- Feature-based decomposition*
- Distortionless sweep algorithm*
- Composite edges*, surfaces
- Boundary layers
- Geometry attributes*
- 3D import mesh
- Mesh containers

* - planned for November '97 release